NAVAL WAR COLLEGE
Newport, R.I.

An Uncertain Superiority:
Information Technology and Operational-Level Decision Making

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College, the Department of the Navy, or the Department of the Air Force.

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05 February 1999

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Security Classification of This Page Unclassified

REPORT DOCUMENTATION PAGE

1. Report Security Classification: UNCLASSIFIED	
2. Security Classification Authority: N/A	
3. Declassification/Downgrading Schedule: N/A	
4. Distribution/Availability of Report: DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.	
5. Name of Performing Organization: JOINT MILITARY OPERATIONS DEPARTMENT	
6. Office Symbol: C	**7. Address:** NAVAL WAR COLLEGE 686 CUSHING ROAD NEWPORT, RI 02841-1207
8. Title (Include Security Classification): (Unclassified) An Uncertain Superiority: Information Technology and Operational-Level Decision Making	
9. Personal Authors: Michael T. Plehn, Major, United States Air Force	
10. Type of Report: FINAL	**11. Date of Report:** 05 February 1999
12. Page Count: 21 (including abstract and table of contents)	
13. Supplementary Notation: A paper submitted to the Faculty of the NWC in partial satisfaction of the requirements of the JMO Department. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC, the Department of the Navy, or the Department of the Air Force.	
14. Ten key words that relate to your paper: Decision Making, Information Technology, Information Superiority, Uncertainty, NCW, JV2010	

15. Abstract:
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16. Distribution / Availability of Abstract:	**Unclassified**	**Same As Rpt**	**DTIC Users**
	X		

17. Abstract Security Classification: UNCLASSIFIED	
18. Name of Responsible Individual: CHAIRMAN, JOINT MILITARY OPERATIONS DEPARTMENT	
19. Telephone: 841-6461	**20. Office Symbol:** C

Security Classification of This Page Unclassified

Abstract of

AN UNCERTAIN SUPERIORITY: INFORMATION TECHNOLOGY AND OPERATIONAL-LEVEL DECISION MAKING

As the world transitions into the information age, commanders at every level will possess enormous amounts of information about their battlespace. This information superiority will improve their ability to command, but will not alter the way they command. Even with near-perfect knowledge, they will still face uncertainty in their decision making processes. To effectively cope with the rising tide of data, commanders must effectively develop and communicate their mental image of a situation to their subordinates so they can efficiently and effectively orient any new observations with the commander's intent.

AN UNCERTAIN SUPERIORITY:
INFORMATION TECHNOLOGY AND OPERATIONAL-LEVEL DECISION MAKING

While the world swims in a newly-formed sea of information created by a flood of sensors, computers, and networks, the United States military stands knee-deep in the waters, wondering what lies below the surface. Several initiatives, like Joint Vision 2010 and Network-Centric Warfare, embrace the rising tide of information, seeking to buoy the nation's future military capabilities on it. At their core, these concepts, and others like them, foresee that information technology will supply a highly accurate depiction of the modern battlefield to commanders at all levels, improving their ability to employ military forces.

Not surprisingly, the rest of the military wonders what lies beneath the surface of this incipient information superiority. Commanders, especially, wonder how they will utilize this capability. With more information at their disposal, they will know more about the disposition, capability, and condition of their own forces, as well as their adversaries' forces, than they have ever known in the past. The proverbial fog of war, if not dissipated, should be lifted somewhat. Consequently, commanders will have more and better information with which to make decisions.

Decision making is more than a simple information-in, decision-out process, though. At some point, information must be analyzed and placed into its proper context to be useful. Imagine putting together a jigsaw puzzle: each piece of the puzzle is considered against the final image as well as the other pieces to determine how it fits into the overall picture. So, too, with information technology and decision making: information must be oriented towards a commander's image to determine how it fits into what he is trying to accomplish.

In Search of Information Superiority

Information superiority, dominant battlespace awareness, common operational picture--diverse means to a similar end: the quest for overwhelming knowledge about the battlefield. As Joint Vision 2010 describes it, the function of dominant battlespace awareness is to "improve situational awareness, decrease response time, and make the battlespace considerably more transparent to those who achieve it."[1] As the United States military begins investing serious financial and intellectual capital in the information age, questioning professionals seek a glimpse into the future of military operations in that age. The obvious question for the commander is, 'how will increased knowledge about the battlespace affect my ability to command?' The complementary, but less obvious, question is, 'will information technology and the accelerating pace of technological change fundamentally alter the *way* I command?'

Those seeking to answer these questions generally fall into one of three categories: the exuberant supporters, the skeptical detractors, and the fence-sitting non-committals. The first group, including Alvin and Heidi Toffler, firmly believes the world is in an information revolution that will fundamentally change the way people, businesses, governments, and military forces perform tasks at every level. The second group, at the other end of the spectrum, believes that humans are more important than hardware and that information technology may influence how *well* the military fights, but not *how* it fights at the most basic and systemic level. The third group has constituents who range between the two ends of the spectrum, but who are generally willing to adopt a wait-and-see attitude toward the value of information technology within the military. So how does one determine which side is right?

One approach suggests examining the question from the logical extreme: possession

of perfect battlefield knowledge. This approach does not recommend that the U.S. military will or should strive to achieve perfect knowledge of the battlefield, but merely allows one to simplify the analysis by, literally, reducing the unknowns.

Lifting the Fog of War...

Carl von Clausewitz described the uncertain state of knowledge on the battlefield, saying, "War is the realm of uncertainty; three quarters of the factors on which action in war is based are wrapped in a fog of greater or lesser uncertainty."[2] Assuming, for the sake of this argument, that one had perfect knowledge of a battlefield, or an area of operations, or a theater of war, one would know exactly what military forces were in the area, both friendly and enemy, precisely where those forces were located, and exactly what capabilities those forces had. When forces moved, or came into contact with each other, one would be aware of that also. Everything physically observable about the battlefield would be known. Essentially, the fog of war would be lifted.

...Reveals a Chess Board

If such were the case, the modern battlefield would look somewhat like a chess board. In the game of chess, each player has perfect knowledge of the physically observable characteristics of the battlespace. Each player knows what forces (pieces) are on the battlefield (chess board). Each player knows where those forces are located at all times. Each player knows the capabilities of all the forces, including movement constraints and attack restrictions. Given this perfect knowledge of the battlespace, why is chess such a difficult game?

Interactivity, Intentions, and Uncertainty

Chess is difficult because, despite complete knowledge of terrain, force location,

capabilities, and a host of other factors, the game is interactive; one player does not know what the other player intends to do with his forces. It is a struggle between the minds of two commanders as much as it is a clash between two opposing forces. While the rules of chess eliminate any uncertainty about the nature of the battlefield and the disposition of the forces on that battlefield, they leave undiminished the uncertainty about the opposing player's intentions. Returning to Clausewitz, "War is the realm of uncertainty...," even when we have a great deal of certainty about some aspects of it.

For Those Who Don't Play Chess

Some might argue that the chess metaphor is a simplistic one that does not account for the complexity of the modern battlefield where even the smallest shreds of information can have a dramatic effect on force employment. For example, what if the helicopter pilots during Operation EAGLE CLAW, the Iranian hostage rescue attempt, had known about the dust storms enroute to their refueling site, or the positions of their fellow pilots' helicopters during the storms, or even that they could have flown above the storms undetected by Iranian early warning radar? Surely they would have made it to the refueling site with six operational helicopters, enough to continue the mission. In all likelihood, they would have made it to the refueling site with enough helicopters to continue the mission had they known any of these things.[3] Even so, that was simply the beginning of the mission, uncomplicated by interaction with opposing forces. As one analysis of the command, control, and communications of this operation noted, "This phase of Eagle Claw--the blacked out, low level, radio silent ingress of the C-130s and choppers...the night refueling operation, securing the area and transferring the assault team from the C-130s to the helicopters deep within a hostile country--was the easy part of the mission!"[4] Many difficult tasks remained between

the ingress and successful mission accomplishment.

So, while the chess metaphor is simplistic, it is so deliberately. The intent is to show that even when one removes uncertainty about the facts, other sources of uncertainty still exist which modern sensors, information technology, and networked communications can do little to ameliorate. Although information superiority is the route to dominant battlespace awareness, that road is pitted with potholes of uncertainty.

Uncertainty and Information

Uncertainty is the concealed, reverse side of the Information coin. While information technology promises to deliver unprecedented levels of data to the commander, the commander must do something with the information. Martin van Creveld states, "The history of command in war consists essentially of an endless quest for certainty."[5] Arguably, the commander will use information superiority, or dominant battlespace awareness, or whatever resources he has available, to reduce his level of uncertainty in order to make better decisions. As Lt Gen (Ret) Van Riper, USMC, noted, "All the information in the world is useless unless it contributes to effective decision making in battle."[6]

Recalling the chess metaphor, a great deal of uncertainty will remain on the future battlefield even after, or if, information technology supplies all of the facts. In their article "Fighting in the Fog: Dealing With Battlefield Uncertainty," Major John Schmitt, USMCR, and Dr. Gary Klein confirm this: "Uncertainty is a fundamental and inevitable attribute of war, and no amount of information technology, no matter how powerful, will eliminate it or even reduce it to the point that it becomes a substantially easier problem. Reducing uncertainty is not simply a problem for improved data processing."[7]

To support this assertion, Schmitt and Klein discuss the causes of uncertainty and the

levels at which one may be uncertain. Uncertainty results from one of the following causes: missing information; unreliable information, due to either a questionable source or outdated information; ambiguous and conflicting information; or, complex information.[8] Information technology should be able to substantially alleviate the first two causes of uncertainty, but will do little for the second two:

> The common assumption is that the principal source of uncertainty is missing information rather than indeterminate information. The focus of the technology effort is on improving the capacity to gather information as opposed to improving the clarity of information. Most technology advancements will not improve the quality of ambiguous or conflicting information; in fact they will generate even more ambiguous and conflicting information.[9]

Significantly, "Ambiguous and conflicting information accounted for nearly 50 percent of all the cases of uncertainty we observed."[10]

In addition to these four basic causes, uncertainty also exists at three different levels: data, knowledge, and understanding.[11] At the data level, one may be uncertain about the factual information itself; at the knowledge level, one may be uncertain about what the information means; or, finally, at the understanding level, one may be uncertain about the outcome of events predicated on other information.[12] Relating this back to information technology, consider the chess board again. With perfect information, one should never be uncertain about the factual information: *QK-QB4, the opposing player moved his Knight; it is sitting on the third square from his right, four rows from his end of the board.* Unfortunately, this information reveals nothing about why the opposing player moved that piece there, or what the eventual outcome of that movement will be. Uncertainty still exists, despite overwhelming battlespace awareness.

In practice, information will not exist in isolation from other, potentially

corroborating or clarifying, information. One knows what pieces are still on the board, what moves have been made, and where the remaining pieces are. Given the power of a networked processing system, as one would see in the age of dominant battlespace awareness, one could examine the data and try to reduce the knowledge or understanding uncertainties associated with a given force movement. For example, IBM's Deep Blue computer system considered 200 million moves every second enroute to defeating world champion Garry Kasparov in a multi-game chess match in 1997.[13] Even so, the computer only had to consider a very limited battlespace with a very small number of forces with clearly defined capabilities. Although the computer mitigated the uncertainties, they still existed and had to be addressed with each new data point. In practice, therefore, the fundamental problem with information uncertainty has little to do with the actual data: "The uncertainty was not over the data; the uncertainty was over what the data meant. Contrary to popular wisdom, the facts rarely speak for themselves; they need a lot of interpretation, and therein lies the problem."[14]

While most would agree that the issue of uncertainty is problematic, some might still argue that the ability of information technology to collect, process, communicate, and share information will transform warfare, nonetheless. After all, a computer defeated a human Grand Master in the game of chess despite the associated informational uncertainties. The computer did not win every game, though, and it did not eliminate uncertainty in any of the games; it merely managed it. The chess board world of perfect information allowed the computer to minimize the causes of information uncertainty, and simply deal with the levels of information uncertainty (i.e., what does the information mean, and what might the outcome of an action be). At this point, the computer was really calculating the adversary's possible courses of action. On a chess board, with only thirty-two maneuver pieces, this was

still a daunting, if mostly achievable task. Even so, the computer analyzed the information, then chose the best possible option--it did not eliminate the uncertainty, it merely managed the remaining uncertainty and made its decision without fully knowing its adversary's intentions. Even in a world of perfect information, interaction between the two sides still created uncertainty. So, although information technology will revolutionize the way data is gathered and shared, it will not eliminate the associated uncertainty. At some point, information must be put to use. When that occurs, interaction breeds uncertainty that rapidly impacts the person, or system, that must act on the information. In essence, information technology may transform information gathering and sharing, but it will not transform the fundamental utility of information in war: making better decisions in battle.

Information and Decision Making

Obviously, then, some level of uncertainty will always accompany information and information technology. Despite this uncertainty, those entrusted with decision-making authority will still have to perform their duties and make decisions, regardless of the level of certainty they possess about their information. Continuing the analysis, one would now question what commanders do with information, be it certain or uncertain. The answer comes from an examination of human behavior in general.

A Model For All Rational Behavior

Colonel (Ret) John Boyd proposes a model that describes all rational behavior, including decision-making, as a continuous, cyclic, four-step process of Observation, Orientation, Decision, and Action; a process that he calls the OODA Loop.[15] No matter what the behavior, it fits into one of the four tasks of this loop. As Figure 1 shows, the model is continuous and interactive, with feedback and control between the various tasks. The most

important feature of the model is the central position of the Orientation phase. Either explicitly or implicitly, it controls all other phases. Orientation, and its associated mental image, is the key to effectively utilizing information in the decision process.

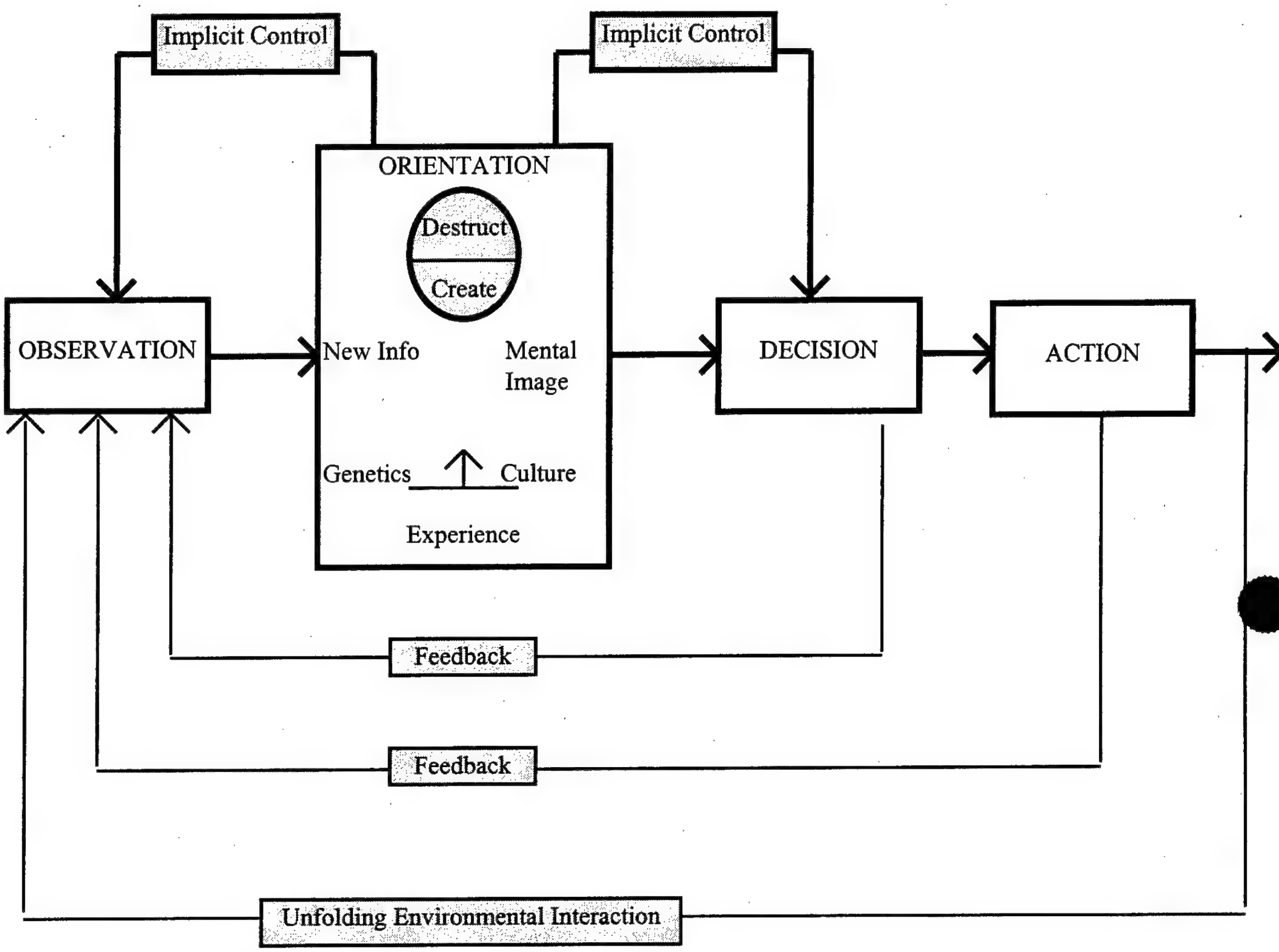

Figure 1. The OODA Loop.[16]

After examining the diagram, some might think that the military application of Boyd's OODA Loop is merely a tactical concept--that it simply describes immediate or responsive behavior. While the OODA Loop does accurately describe behavior at the tactical level, it also accurately models behavior at the operational, and even strategic, level. The key to applying the OODA Loop model at the operational and strategic levels is the realization that

observation and orientation are continuous processes. As shown in Figure 1, every observation supplies new information to the Orientation task. Through a process of destruction and creation, the new information is analyzed and synthesized with existing environmental, genetic, and cultural information in order to develop a mental image of the world.[17] From this orientation, individuals make decisions and take actions. Understanding that National Military Strategy, objectives, and even public aversion to casualties, among other influences, are either environmental, cultural, or observational inputs to the orientation task, one quickly realizes that the OODA Loop fully describes the deliberative behavior that is characteristic of decision making at the operational and strategic levels of war.

Information and Communication

Clearly, the purpose of information is to facilitate better decision making. Information exists, and is created, within all sections of the commander's OODA Loop. Information technology will supply even more information to this process. Through feedback, all information is eventually considered within the Orientation task, where it may, or may not, become part of the mental image that is used to make a decision. This mental image, developed through a process of Orienting a new piece of information with an existing mental image derived from previous informational, environmental, cultural, and genetic factors, is the crucial output of Orientation that leads to Decision. Kahan, et al., frame the importance of this mental image to the commander:

> The commander seeks a dynamic *image* of the battlefield that will lead him to understand what action needs to be taken. This image, which is the commander's mental model of the battlefield and its contextual surroundings, includes military, political, and psychological considerations...The *meaning* of any information gained by the commander is driven by the image that frames it...a major purpose of communications in the command-and-control process lies in the sharing of images.[18] [emphasis in original]

In this paragraph, Kahan and his colleagues connect the value of information to image building, further linking that to the communication of information and the sharing of images in the command-and-control function. This process of mental image building, which is also the output of Boyd's Orientation task in the OODA Loop, is crucial to decision making.

Information and the Production of the Mental Image

The role of information for the commander, then, as shown by Boyd's model and confirmed by Kahan's research, is to assist in the production of a mental image of a situation. From the high-quality information backplane that hosts the Network-Centric Warfare model, to the information superiority required for the Dominant Battlespace Awareness envisioned by Joint Vision 2010, a deluge of information will flow towards the commander. Not all information is relevant to the development of an image, however; herein lies the dichotomy of the Information Age: the very volume of data which is supposed to assist the commander in generating an accurate mental image of a given situation may slow the Orientation process which develops that image to a standstill.

At the operational level, subordinates who understand what the commander is trying to accomplish are the breakwater for controlling the flood of information cascading toward him. In terms of the OODA Loop, staff members must share a congruent Orientation with the commander so they can exercise implicit control over the observations to prevent extraneous information from being introduced into the loop and slowing down the Orientation, Decision, and Action processes. Kahan and his associates recognize the value of having staff and commanders share the same orientation, "Therefore, staff members must share their commander's image if they are to understand and supply his information needs."[19]

Commander's Intent

Another way of thinking about the mental image that both Boyd and Kahan advocate is in terms of the commander's intent. The commander's intent is his vision of a situation; how he perceives a situation in its current state, how he will act to alter the situation, and what the situation should look like when he is finished.[20] This intent is the mental image toward which a commander will orient new observations and information, and which will guide his decisions and actions. Likewise, this intent allows subordinate commanders to effectively align their own observations, decisions, and actions with their commander's mental image to create a unity of effort toward achieving a common goal.

In short, intent expresses a commander's Orientation and serves as a compass for subordinates to orient their own observations, enabling them to make decisions and take actions that are consistent with the commander's mental image. "Effective commanders tend to have the ability to explain their intent and their understanding of the situation clearly. They generate clear expectancies so that later on they and their subordinates can quickly determine whether events are going as intended."[21]

Putting the Pieces Together

Some fundamental characteristics of information and decision making emerge from this discussion. First, even with the possession of perfect information, uncertainty still exists. In the face of less-than-perfect information, even more uncertainty exists. Second, although information is critical to the decision making process, the information must be relevant to the decision maker--it must be oriented toward the decision maker's mental image. Third, those who supply information to the commander have a better context for collecting and disseminating information when they share the commander's image.

Ultimately, decision making is more complex than simple information gathering and information sharing. One might have a bucket of jigsaw puzzle pieces, but without the image on the box, one would have little idea how to fit those pieces together, much less what picture they form. So, too, with information technology and decision making. Commanders must develop their mental image, or intent, of a situation and share it with their subordinates, so they know what pieces of information are relevant to a situation. Knowing this, subordinates can control the flow of information to the commander so he is not overwhelmed by a mass of data. Even so, a great deal of effort is still required by intelligence and information professionals to examine the discrete pieces, determine how they match up with the desired image, and then correctly place them in the framework.

Finally, even with all of the pieces of the information puzzle correctly linked, the commander must still cope with different levels of uncertainty--a perfect picture of the battlespace will not eliminate that. Working with the intelligence community, the commander must assess the information and determine how it affects his own courses of action. In the words of Kahan and his fellow RAND colleagues, "Commanders need options and assessments that are relevant to the shared image...Hence, a commander looks to his G2 for his *assessment* of the enemy's intentions, not just for a litany of intelligence estimates of enemy position. [emphasis in original]"[22] Accurately determining enemy intentions, a difficult and dicey chore at best, would be the pinnacle of applied information technology. As the Chinese master Sun Tzu said, "If you know the enemy and know yourself, you need not fear the result of a hundred battles."[23]

Conclusion

Information technology will provide a superior, if not dominant, amount of

information to commanders at the tactical, operational, and strategic levels of war. At some point in the future, this information will coalesce into a very accurate picture of the battlespace. Uncertainty exists even in the face of perfect information, though, and commanders must still grapple with it while making decisions.

Like all rational creatures, they will continuously cycle through a process of observing new information, orienting that information to a mental image, making a decision consistent with that image, and then acting upon the decision. The most critical step in the decision making process is developing an accurate mental image of a situation and effectively orienting new information to the image. With the overwhelming amount of data that information technology will supply to the commander, staff officers must share this image to efficiently present relevant information for the commander's consideration.

In short, to answer the questions posed earlier, information technology will improve a commander's ability to command, but will not alter the way he commands. In the way of improvements, information technology will reduce, but not eliminate, the amount of uncertainty in the decision making process. Perhaps more significantly, information technology has the potential to clearly transmit the commander's mental image to his subordinates. A clearer image, fully encompassing the commander's intent, will generate a unity of effort among forces that will dramatically improve his ability to command. On the other hand, information technology will not substantially alter the way commanders perform their command function. Theirs is still a job of developing an accurate mental image of a situation, conveying that image to their subordinates, and making decisions in the face of uncertainty.

Recommendations

Operational-level commanders should aggressively encourage the use and proliferation of information technology within their staffs and subordinate organizations. Although information technology cannot eliminate uncertainty, it can still reduce it, and that will lead to better information on which to base decisions. Most importantly, as information technology continues to mature, operational-level commanders should have their staffs attempt to graphically capture the commander's intent, or commander's mental image of the situation, so it can be transmitted to subordinate-level commanders. Dynamic display technologies and moving map displays are prime candidates for presenting the commander's image, since they capture and depict a great deal of information in a readily comprehensible format.[24] Finally, operational-level commanders should ensure that their administrative and intelligence staff officers are actively engaged in fusing all information sources together in order to provide the commander with information that is clear and supporting. For the intelligence functions, this should entail a vigorous attempt to fuse HUMINT sources with networked, sensor-based, factual information to better discern enemy intentions, thereby further reducing the level of uncertainty in the commander's decision-making process.

NOTES

[1] Joint Chiefs of Staff, Joint Vision 2010 (Washington, D.C.: 1996), 13.

[2] Carl von Clausewitz, On War, indexed ed., edited and translated by Michael Howard and Peter Paret, (Princeton, New Jersey: Princeton University Press, 1984), 101.

[3] James H. Kyle, The Guts to Try, (Phoenix, AZ: Primer Publishers, 1995), 334-335.

[4] Stephen E. Anno and William E. Einspahr, "Command and Control and Communications Lessons Learned: Iranian Rescue, Falklands Conflict, Grenada Invasion, Libya Raid," (Maxwell AFB, AL: Air University, Air War College, 1988), 4.

[5] Martin van Creveld, quoted in James P. Kahan, D. Robert Worley, and Cathleen Stasz, Understanding Commanders' Information Needs, R-3761-A, (N.p.: RAND, 1989), 16.

[6] Paul K. Van Riper and F. G. Hoffman, "Pursuing the Real RMA: Exploiting Knowledge-Based Warfare," National Security Studies Quarterly, Summer 1998, 7.

[7] John R. Schmitt and Gary Klein, "Fighting in the Fog: Dealing With Battlefield Uncertainty," Marine Corps Gazette, August 1996, 63.

[8] Ibid., 63.

[9] Ibid., 63.

[10] Ibid., 63.

[11] Ibid., 64.

[12] Ibid., 64.

[13] Steven Levy, "Garry Sings the Blues," Newsweek, May 26, 1997, 84. IBM's Deep Blue beat world chess champion Garry Kasparov in a multi-game match in May, 1997.

[14] Schmitt and Klein, 64.

[15] David S. Fadok, John Boyd and John Warden: Air Power's Quest for Strategic Paralysis, (Maxwell AFB, AL: Air War College, School of Advanced Airpower Studies, Air University Press, 1995), 16.

[16] Ibid., 16.

[17] Ibid., 17.

[18] Kahan, et al., vi.

[19] Ibid.

[20] Naval War College, Commander's Estimate of the Situation, NWC 4111C, (Newport, RI: n.d.), 1-2 and 1-3.

[21] Schmitt and Klein, 67.

[22] Kahan, et al., 19.

[23] Sun Tzu, The Art of War, ed. James Clavell, trans. Giles, 18.

[24] Kahan, et al., 80-81.

Bibliography

Allen, Bernal B. "The Non-Linear Nature of Information and its Implications for Advanced Technology Forces." Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1998.

Anno, Stephen E. and William E. Einspahr. "Command and Control and Communications Lessons Learned: Iranian Rescue, Falklands Conflict, Grenada Invasion, Libya Raid." Maxwell AFB, AL: Air University. Air War College, 1988.

Cebrowski, Arthur K. and John J. Garstka. "Network-Centric Warfare: Its Origin and Future." U.S. Naval Institute Proceedings, January, 1998, 28-35.

Ellis, Jeffrey A. "Joint Vision 2010: Information Superiority and Its Effect on the Command and Control Process." Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1998.

Fadok, David S. John Boyd and John Warden: Air Power's Quest for Strategic Paralysis. Maxwell AFB, AL: Air War College, School of Advanced Airpower Studies, Air University Press, 1995.

Gilroy, Michael P. "The End of History and the Last Soldier: Training Military Leaders to Operate With Information Superiority." Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1998.

Hayes, Steven D. "Information Superiority: Teaming the Commander and the 'System of Systems' in 2010." Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1998.

Kahan, James P., D. Robert Worley, and Cathleen Stasz. Understanding Commanders' Information Needs. R-3761-A. N.p.: RAND, 1989.

Kuhn, James K. "Network Centric Warfare: The End of Objective Oriented Command and Control?" Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1998.

Kyle, James H. The Guts to Try. Phoenix, AZ: Primer Publishers, 1995.

Levy, Steven. "Garry Sings the Blues." Newsweek, May 26, 1997, 84.

McMurry, Robert D. "Dominant Battlespace Knowledge: Considerations for the Commander." Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1998.

Roman, Gregory A. "The Command *or* Control Dilemma," in <u>Essays on Strategy XIV</u>, Edited by Mary A. Sommerville. Washington: National Defense University Press, 1997, 149-185.

Schmitt, John R. and Gary A. Klein. "Fighting in the Fog: Dealing With Battlefield Uncertainty." <u>Marine Corps Gazette</u>, August 1996, 62-69.

Sun Tzu. <u>The Art of War</u>. Edited by James Clavell. Translated by Giles. New York: Delacorte Press, 1983.

Tanner, Nancy L. "The Double Edged Sword: Information Superiority or Information Vulnerability of <u>Joint Vision 2010</u>." Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1997.

Toffler, Alvin and Heidi. <u>Powershift</u>. New York: Bantam Books, 1990.

U.S. Joint Chiefs of Staff. <u>Joint Vision 2010</u>. Washington: 1996.

U.S. Naval War College. <u>Commander's Estimate of the Situation, NWC 4111C</u>. Newport, RI: n.d.

Van Riper, Paul K. and F.G. Hoffman. "Pursuing the Real RMA: Exploiting Knowledge-Based Warfare." <u>National Security Studies Quarterly</u>, Summer 1998, 1-19.

Viland, Michael S. "War in the Information Age: A Model for Command and Control Warfare." Unpublished Research Paper, U.S. Naval War College, Newport, R.I.: 1998.

von Clausewitz, Carl. <u>On War</u>, indexed ed. Edited and translated by Michael Howard and Peter Paret. Princeton, New Jersey: Princeton University Press, 1984.